

EFFECT OF COOKING METHODS ON OMEGA-6/OMEGA-3 AND HYPO/HYPERCHOLESTEROLEMIC RATIOS OF BENI-GUIL LAMB MEAT FROM EASTERN MOROCCO

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INTRODUCTION

Meat cooking is essential to improve meat consumers palatability. In fact, thermal treatments improve hygienic quality of meat (deactivation and elimination pathogenic microorganisms), increase its shelf life, enhance its organoleptic quality flavor, tenderness and color (Modzelewska-Kapituła et al., 2012). However, meat cooking modify chemical composition (fatty acids, amino acids,...) by losses with a consequent change of the meat nutritional value. Fat and fatty acids composition of meat are a very important criteria for a good health (Wood et al., 2004). Also, it's very important to know that an imbalanced polyunsaturated fatty acids (PUFA)/saturated fatty acids (SFA) and a high n-6/n-3 ratios may cause serious health problems such as cardiovascular disease, obesity and certain cancers (Simopoulos, 2002, Simopoulos, 2016). Moreover, those parameters are very influenced by cooking methods (Flakemore et al., 2017). The objective of this study is to compare and determine the effect of two Moroccan cooking methods (Barbecue and Tajine) on nutritional quality of Béni-guil's lamb meat especially the omega-6/omega-3 and hypo/hypercholesterolemic ratios.

MATERIAL AND METHODS

The trials were conducted on the *Longissimus Lumborum* (LL) of Béni-guils lamb meat obtained 24h *postmortem* (one muscle for each carcass). The pH ultimate was analyzed to avoid anomaly carcass, by using a portable pH meter (pH/Cond 340i WTW, Weilheim, Germany), equipped with a penetration electrode. Then, we divided the samples into three groups according to cooking methods (30 samples for each group). A total of 90 samples were obtained including one group used as control. Meats, denuded of external fats were cooked, to a core temperature of 70 °C, using two Moroccan meat cooking methods: grilled using an electrical griddle (dry cooking) and Tajine using 20 ml of water (moist cooking). After cooking the samples were freezed, lyophilised, crushed and stored at -20 °C for subsequent fatty acids analysis.

Fatty acids profil

The intramuscular fat was extracted according to Bligh and Dyer (1959) using a chloroform/methanol/water mixture (2/1/1; v/v/v). The lipid extract was methylated and converted to fatty acid methyl esters (FAME) according to the method described by (Ben Moumen et al., 2015). Separation of the FAME was performed on an Agilent gas chromatograph (GC) (HP6890 series, Agilent Technologies, USA), equipped with an Omegawax capillary column (30 m × 0.25 mm × 0.25 µm film thickness) from Supelco (Bellefonte, PA, USA) and a flame ionisation detector (FID). Helium (99.999%, Air Liquide, Liège, Belgium) was used as the carrier gas, at a flow rate of 1.7 ml min⁻¹. The temperature of the injector and detector were set at 150 and 250 °C, respectively, and the oven temperature was set at 210 °C. The injection volume was 1 µl, in splitless mode. A FAME standard, containing 37 components (Supelco, Bellefonte, PA, USA), was used to identify the individual peaks.

Statistical analysis

The analysis of effect's cooking methods (Barbecue and Tajine) on nutritional value was carried out on triplicate for each sample and each parameter. All statistical analysis were conducted using Statistical Package for the Social Sciences (SPSS for Windows, version 20, SPSS Inc., Chicago, IL, USA). The normal distribution was verified according to Shapiro Wilk test. One-way ANOVA statistical analysis and Duncan's post-hoc test was used for means comparison, the difference was considered significant (at $P < 0.05$).

RESULTS

The mean value of pH₂₄ of *LL* used in this study was 5.66. The results showed that 100g of raw meat contains 6.14% (table 1) of intramuscular Fat (IMF). The effect of cooking methods showed that Barbecue cooking method preserved its IMF than Tajine cooking method with a content of 5.31% and 4.83% (table 1) of fresh meat, respectively. The effect of cooking methods on fatty acids ratios and sums of Béni-guil's lamb meat produced in eastern Morocco are summarized in Table 1.

Table 1: Cooking methods effect on cooking loss, IMF and fatty acids ratios and sums of Béni-guil's lamb meat

Fatty acids (%)	Raw meat	Cooking method	
		Barbecue	Tajine
SFA	46,67 ^a	42,21 ^b	44,23 ^c
PUFA	9,47 ^a	21,93 ^b	16,36 ^c
UFA	53,32 ^a	57,78 ^b	55,76 ^c
UFA/SFA	1,14 ^a	1,39 ^b	1,27 ^c
PUFA/SFA	0,20 ^a	0,54 ^b	0,38 ^c
n-6	7,79 ^a	18,70 ^b	14,15 ^c
n-3	1,46 ^a	2,69 ^b	1,81 ^a
n-6/n-3	5,70 ^a	7,92 ^a	11,45 ^b
h/H	1,62 ^a	2,17 ^b	1,98 ^b
Cooking loss	---	21.14 ^a	27.06 ^b
IMF	6.14 ^a	5.31 ^b	4.83 ^c
pH	5.66	---	---

Significant differences are shown by different letters (a-c)

SFA: Saturated fatty acids; PUFA: Polyunsaturated fatty acids; UFA: Unsaturated fatty acids;

n-6 : n-6 PUFA; n-3 : n-3 PUFA

h/H = $(18:1n9c + 18:2\omega6 + 20:4\omega6 + 18:3\omega3 + 20:5\omega3 + 22:5\omega3 + 22:6\omega3) / (14:0 + 16:0)$.

DISCUSSION

The result for cooking loss showed that thermal treatments induced an internal juice loss in meat. The smallest internal juice loss value was recorded in barbecue (21.14%) than Tajine cooking method (27.06%). So, the first cooking method holds back its internal juice than the second one. Similar result was reported by other authors (Lorenzo et al., 2015). Also, the barbecue cooking method allows high preservation of IMF than Tajine with 6.14%, 5.31% and 4.83% for fresh meat, barbecue and Tajine respectively. Consequently, Barbecue method guaranteed a better juiciness than Tajine method. GC-FID analysis revealed a significant effect of cooking methods on fatty acids profile and ratios (Table 1). The saturated fatty acids (SFA), polyunsaturated fatty acids (PUFA), and unsaturated fatty acids (UFA) percentages were very influenced by cooking methods. Barbecue cooking methods improves meat nutritional value by increasing PUFA fraction. So, the increase of PUFA/SFA ratio ranged between 0.20, 0.38 and 0.54 for Raw meat, Tajine and barbecue respectively. Similar outcomes were found by other authors (Ramamurti, 1986, Domínguez et al., 2015). This implies an increase, of hypocholesterolemic fatty acids and therefore an increase of the h/H cholesterol ratio which helps reduce cardiovascular disease. The h/H ratio found for Barbecue cooking method (2.17) was higher than those reported in Spanish (Campo et al., 2013) and Australian (Flakemore et al., 2017) lamb meats.

This result can be explained by cooking and drip loss, because the proportional change in fatty acids composition and this is consistent with the results reported by Ramamurti (1986). Additionally, the n-6/n-3 ratio was affected by cooking methods. The results of n-6/n-3 ratio in our study is higher than those reported in beef (Alfaia et al., 2010) and in foal (Domínguez et al., 2015) meats.

CONCLUSION

For the first time we studied the effect of different Moroccan's cooking methods on nutritional quality of the Béni-Guil Protected Geographical Indication meat from eastern Morocco and we conclude that from a taste, nutritional and dietary quality point of view barbecue cooking method allows better preservation of meat nutritional quality than Tajine and it is the cooking method to be recommended.

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